Evaluation of SSMIS Upper Atmosphere Sounding Channels for High-Altitude Data Assimilation

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(See paper with same title in Monthly Weather Review, in press)

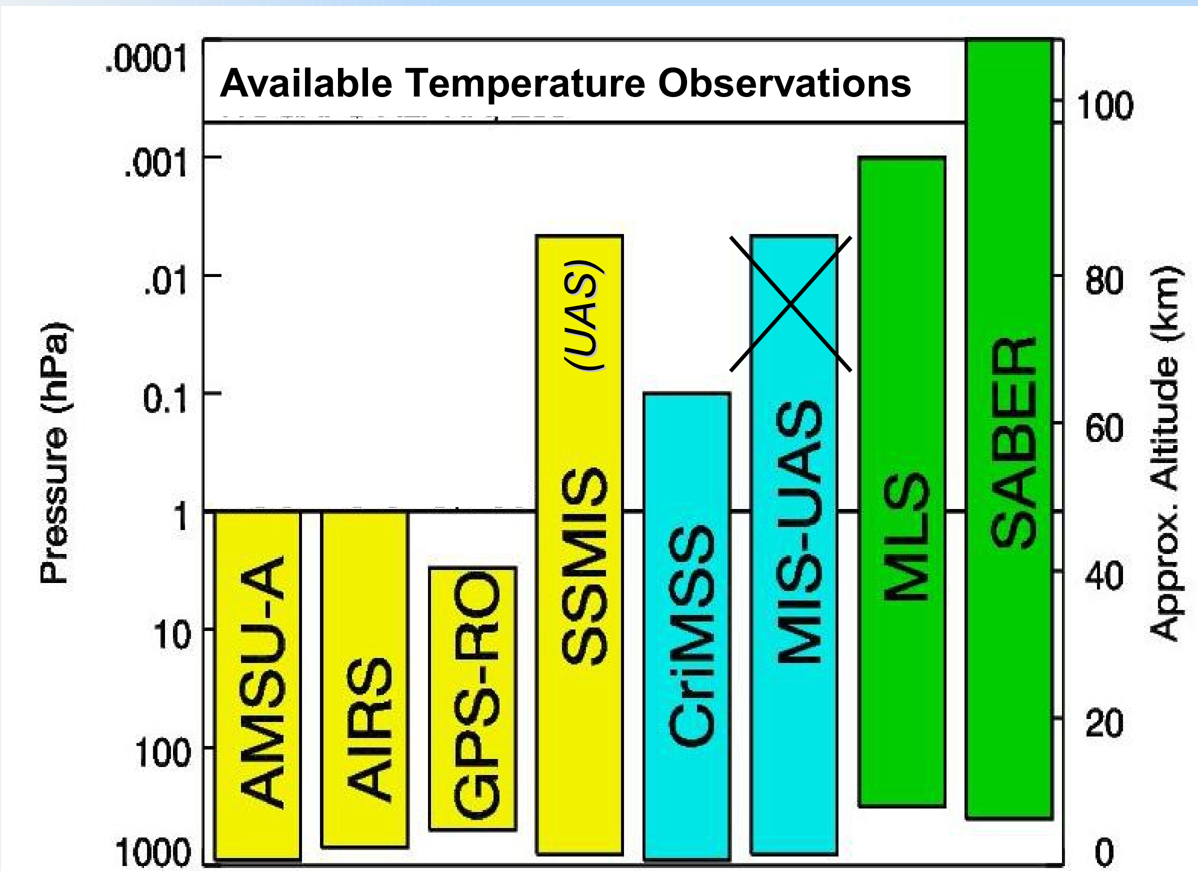
**Now at Science Systems and Applications Inc., Lanham, MD*

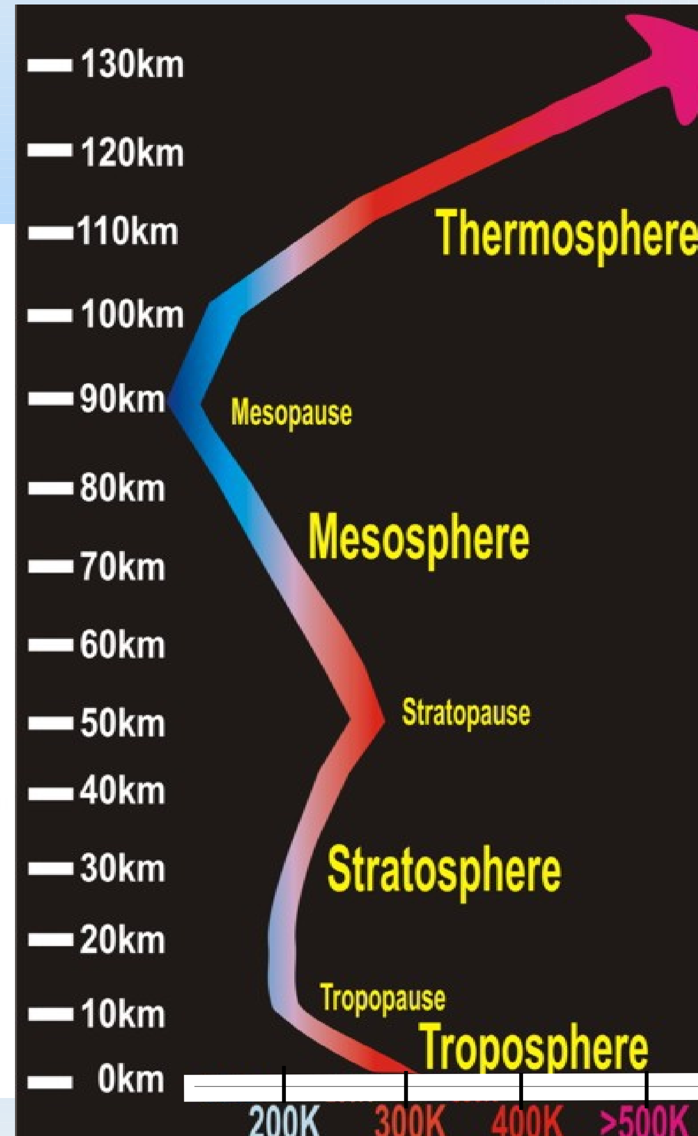
Middle atmosphere temperature observations

Current Operational

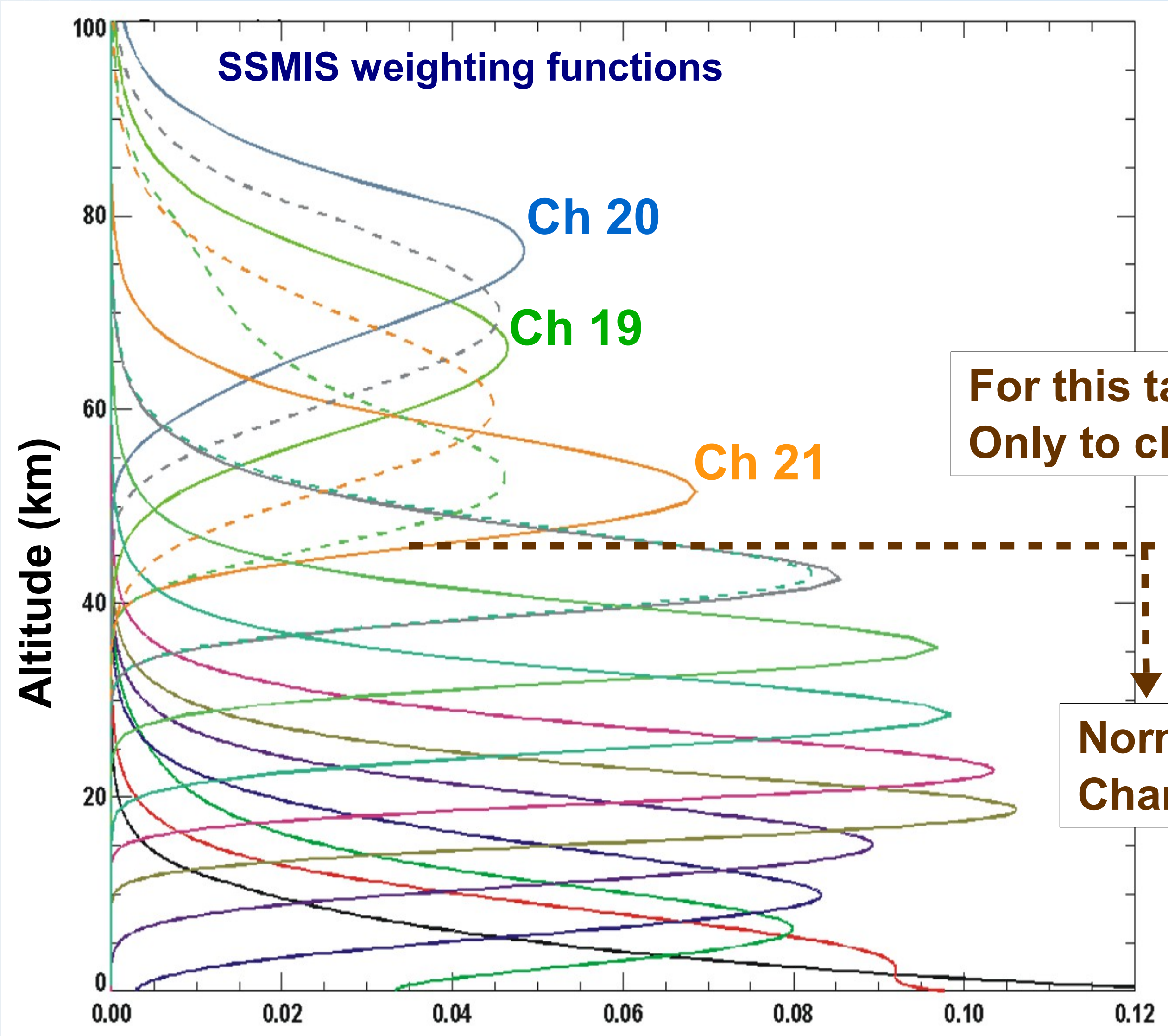
Future operational (JPSS/DWSS)

NASA research instruments





SSMIS-UAS weighting functions with Zeeman splitting



Zeeman splitting illustration:

Weak B field (equatorial)

Strong B field (polar)

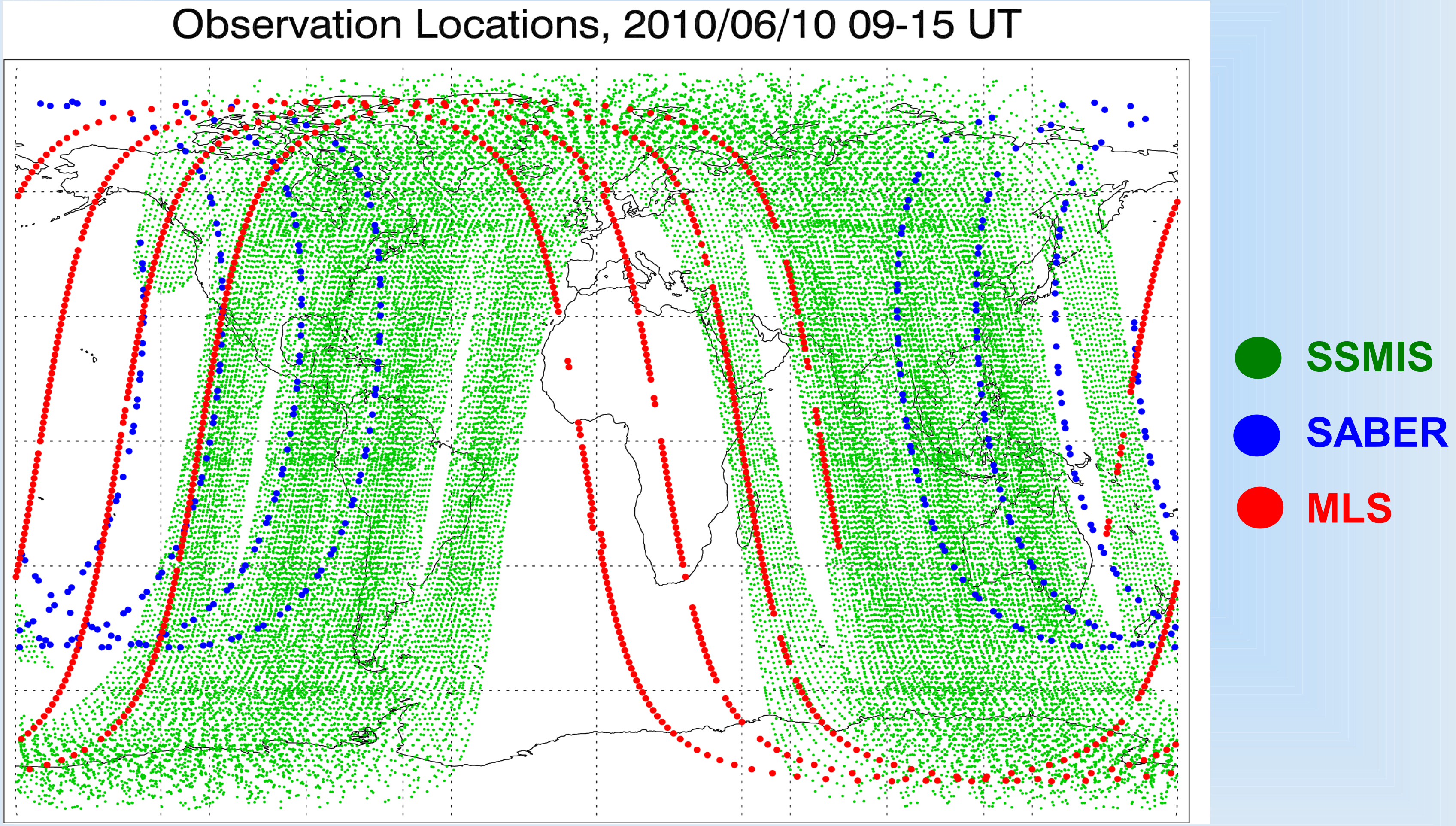
For this talk, "UAS" refers Only to ch 19, 20, 21

Normal Channels

- **Weighting function shifts in altitude when B field changes**
- **For channel 19, shift corresponds to ~10 K change**

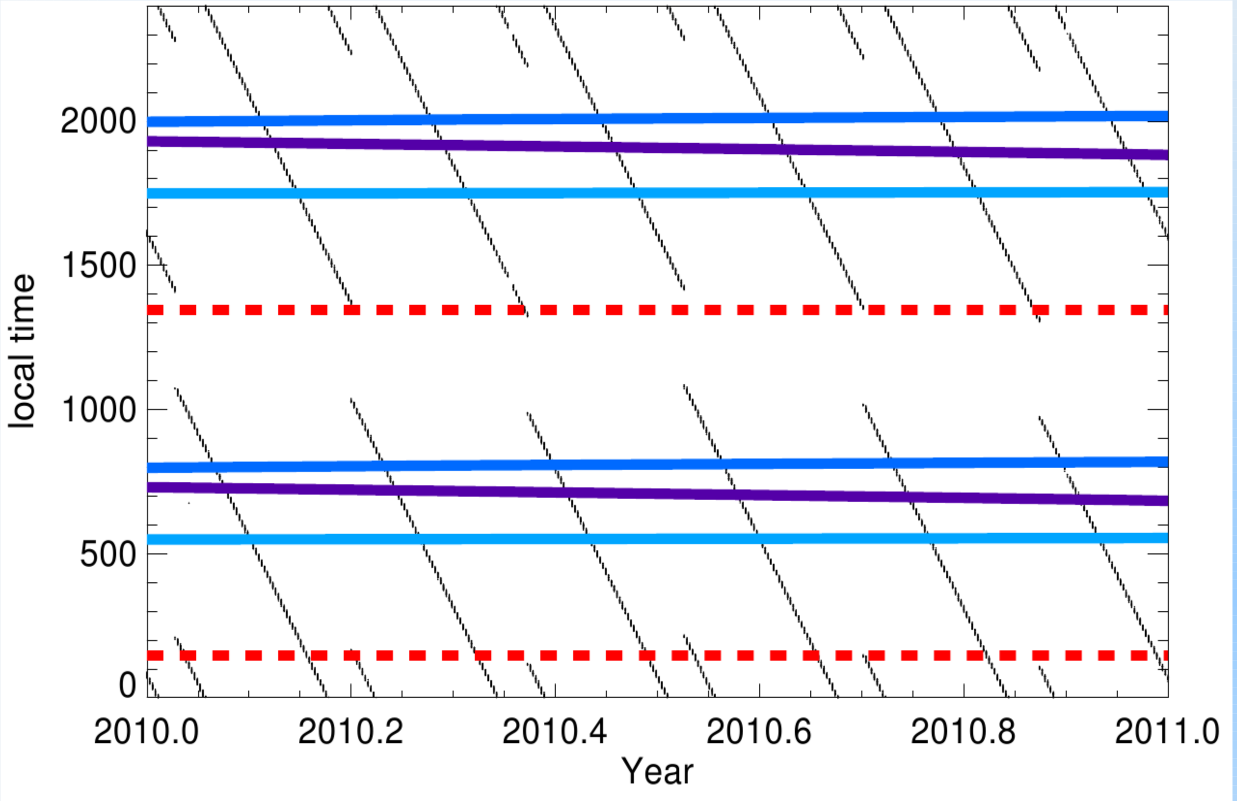
SSMIS, SABER, and MLS Coverage

- Looking for spatial coincidences
- Figure also illustrates the coverage for a 6hr analysis cycle



Measurement locations for MLS, SABER and SSMIS on F16, F17 and F18; 10 June 2010 for the 1200 UTC analysis.

Local time at equatorial crossing



Measurement times (HHMM):

SABER (thin black),

MLS (red dash)

DMSP F16, F17, and F18

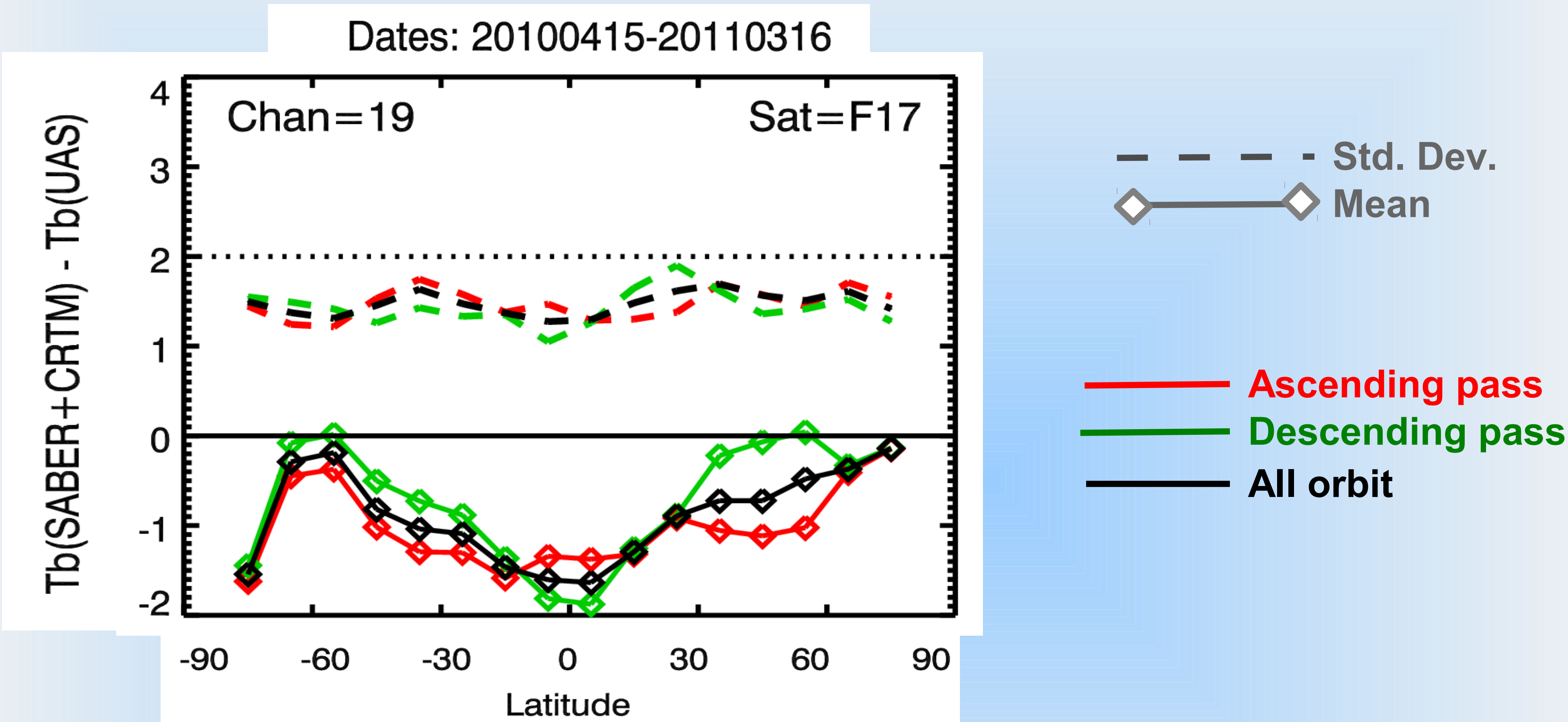
- **No close MLS time coincidences (except near pole).**
- **Saber coincidences periodic in time.**
- **Ascending and descending coincidences at different local times**

SABER-UAS comparison methodology

- Coincidence criteria:
  - +/- 3 Hours, 1 degree (~111 km) separation.
  - Data from the 15th day of each month, Apr 2010 to Mar 2011
  - ~35000 total coincidences per SSMIS instrument
- Simulated brightness temperatures (Tb)
  - SABER Temperatures from 10 hPa to 0.001 hPa
  - GEOS-5 temperatures from surface to 10 hPa.
  - Geomagnetic field and observation geometry from NRL-UAS preprocessor
  - CRTMv2 calculates simulated UAS Tb

Results: Tb(SABER+CRTM) - Tb(UAS)

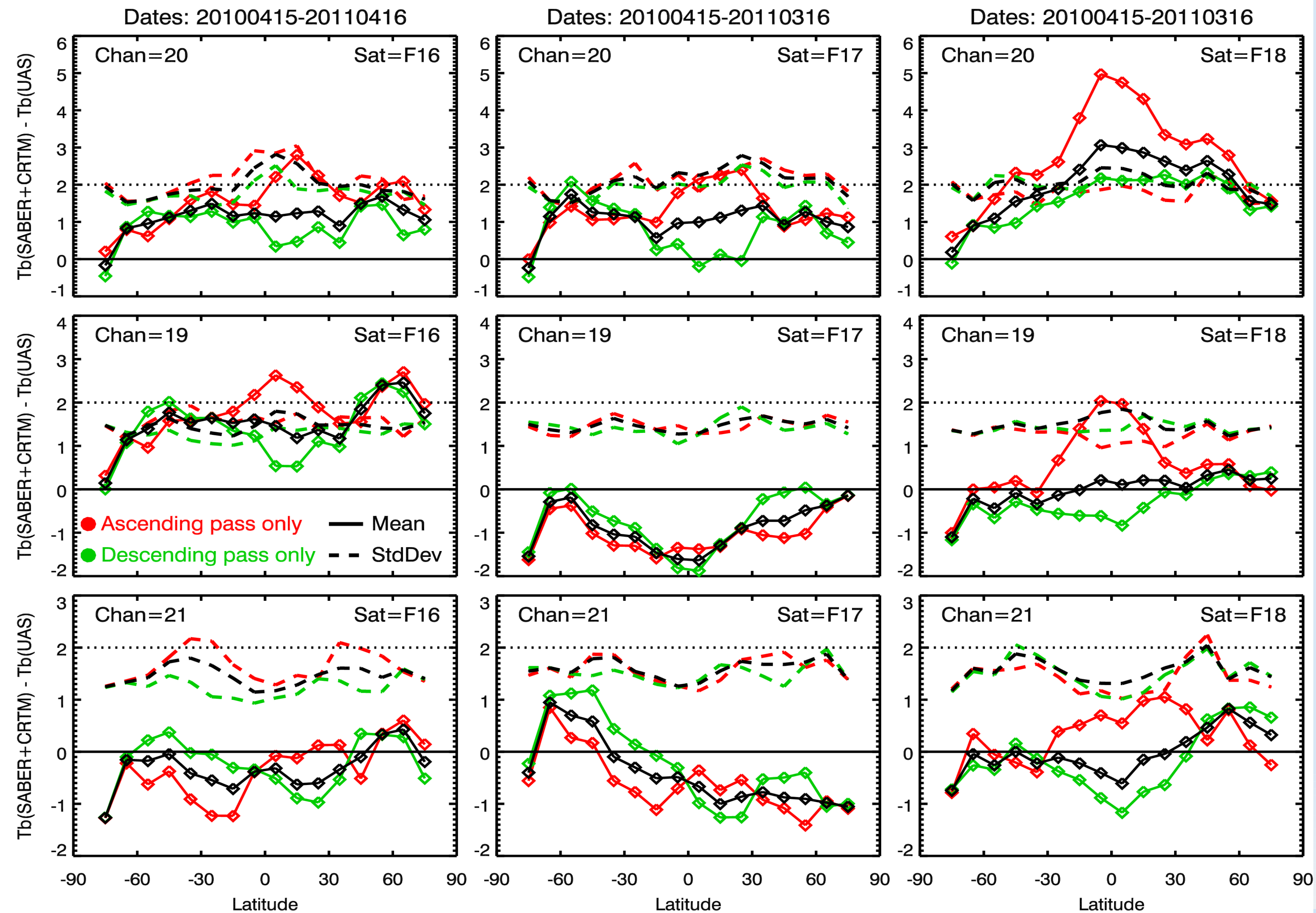
SABER–UAS comparison results



- **Std Dev. is reasonable, given the Ch 19 random error of ~1.2 K**
- **Global mean bias should be removed by bias correction schemes.**
- **No explanation for meridional variations, but they are generally < ~2K**
- **Uncorrected 2K errors are less than typical model biases in mesosphere**

SABER–UAS comparison results

Ascending pass
Descending pass
All orbit
Standard Deviation
Mean

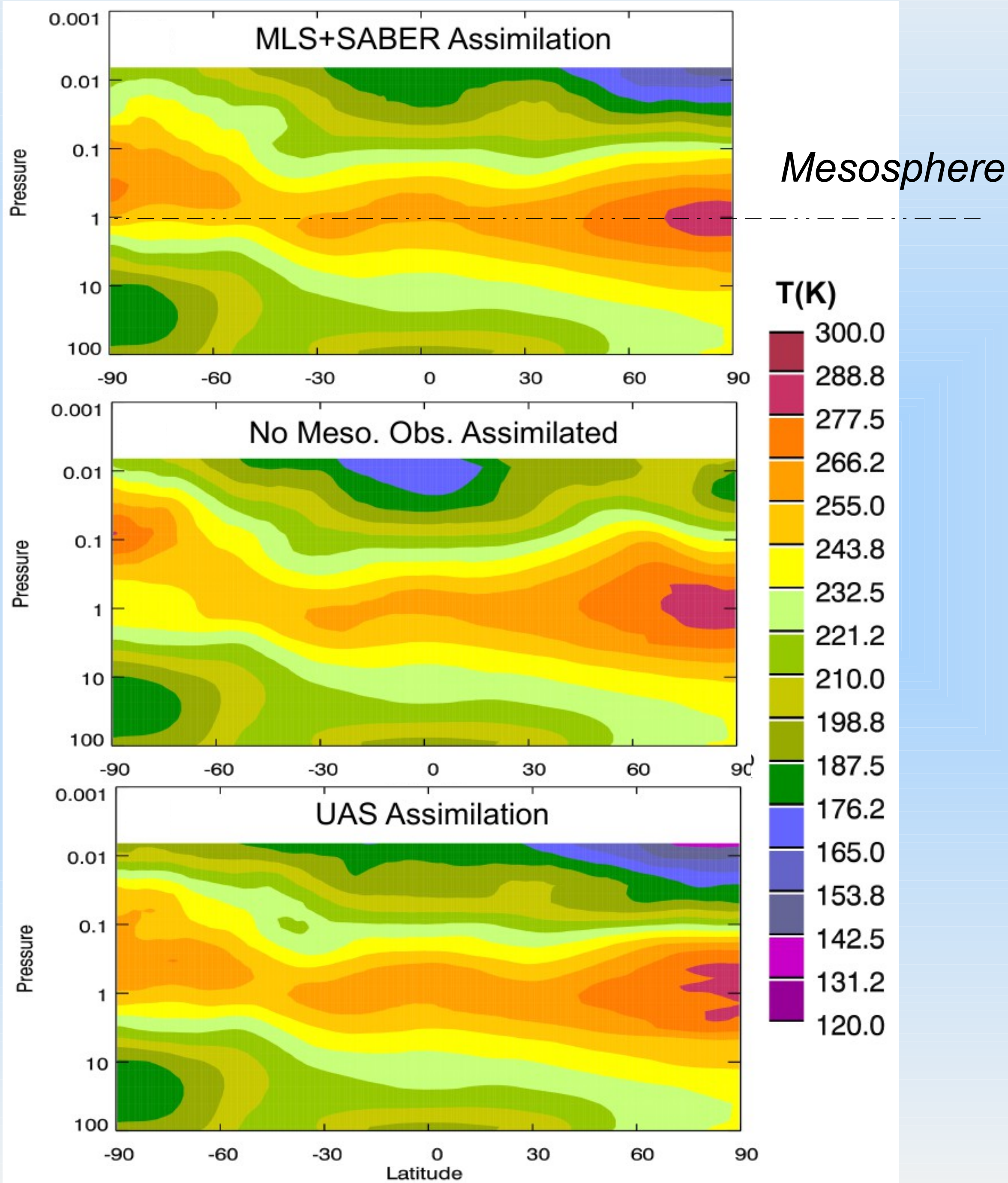


Navy Global Environment Model (NAVGEM) experiments

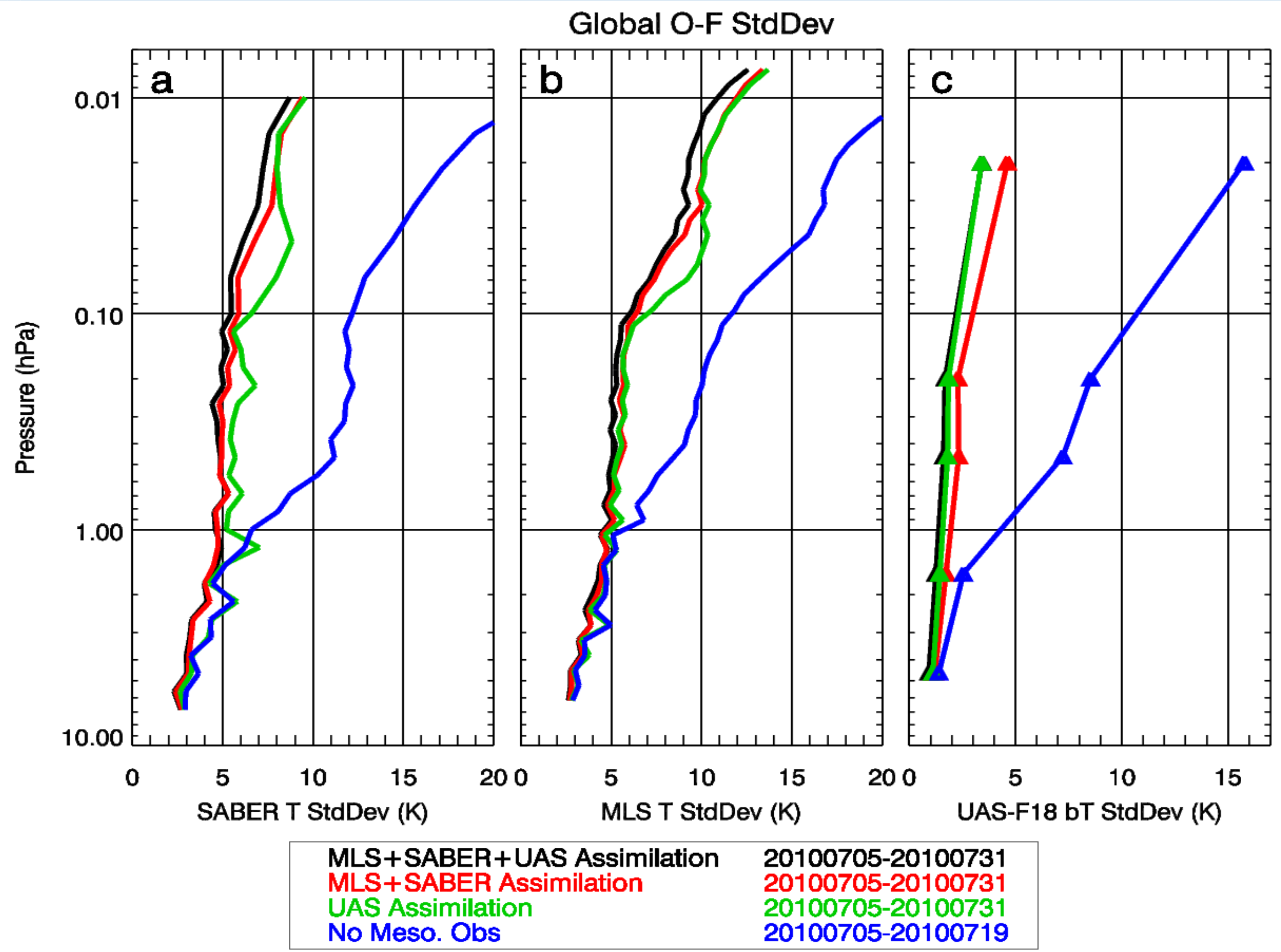
- NAVGEM: Navy's operational 4DVar NWP system.
- Modifications for this study:
  - Model top raised to 0.005 hPa (with ~2 km resolution in middle atmosphere)
  - Horizontal resolution of 0.75^{o} (T239)
  - Non-orographic Gravity Wave Drag parameterization added
  - Ozone climatology used by RRTMG modified
  - Limited tuning of GWD to produce “reasonable” mesosphere
- Mesospheric physics not sufficiently developed; assimilation needed to correct biases.
- 4 analysis experiments for July 2010 with different mesospheric observations:

1. MLS+SABER assimilation
2. MLS+SABER+UAS assimilation
3. UAS assimilation
4. No Mesospheric Obsrvations (NoMesoObs)

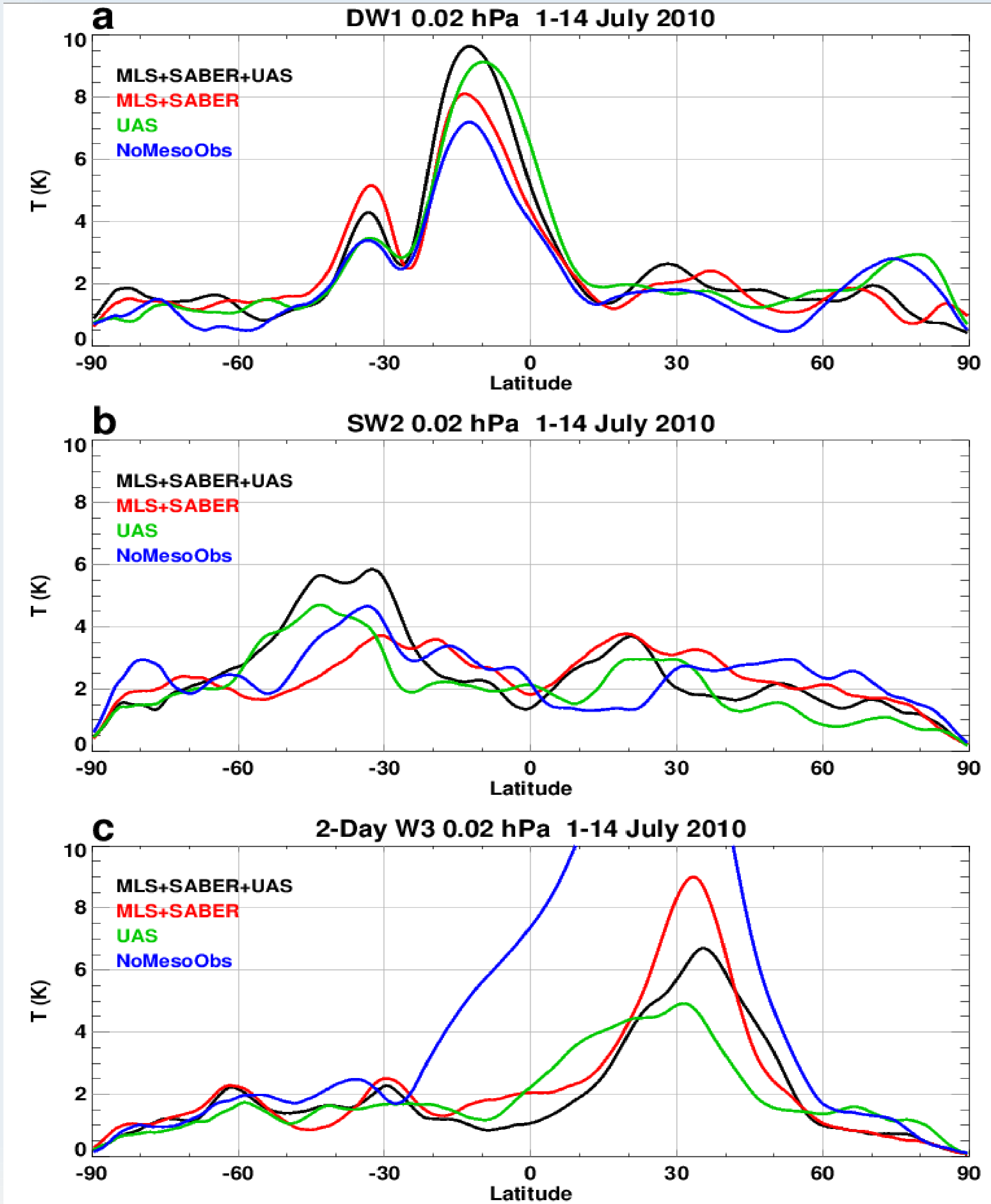
Zonal mean analysis temperature, 14 July 2010, 1200 UT



Observation-Forecast (O-F) for July 2010



Comparison of dominant waves in the mesosphere



Peak Temperature amplitude at 0.02 hPa (~76 km) for:

(a) DW1; diurnal migrating tide

(b) SW2; semidiurnal migrating tide

(c) Q2DW3; quasi-2-day wave

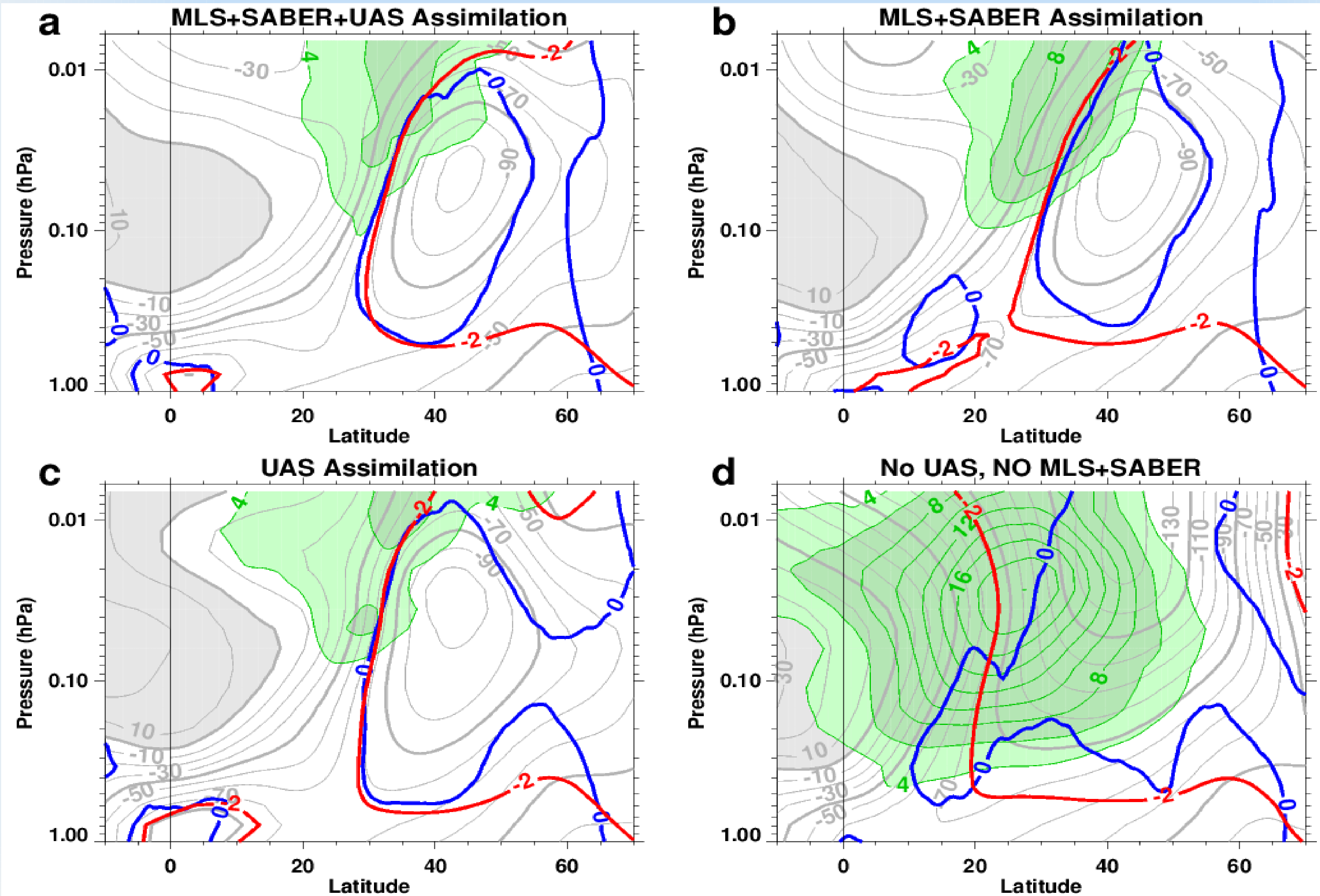
Zonal-mean winds during 1-14 July 2010

Amplitude (K) of Q2DW3

Zonal Wind

2-day, wave-3 critical line

Zero line of meridional gradient of quasi-geostrophic PV



Conclusions/Discussion

- UAS comparisons with coincident SABER+CRTMv2 simulated Tb compare well; StdDev < ~2K.
- UAS assimilation improves mesospheric analysis.
- UAS assimilation is valuable for quantifying forecast model biases.
- Future UAS-like measurements (beyond SSMIS) are important, but not planned.

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